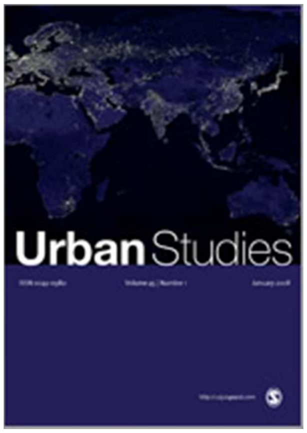

A new perspective on the ripple effect in the UK housing market: Comovement, cyclical subsamples and alternative indices

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ABSTRACT

An alternative perspective is provided on the existence of a ripple effect in the UK housing market. In contrast to previous studies, the analysis involves consideration of information on the *changes* in house prices to which the hypothesis of house price diffusion posited by the ripple effect relates, rather than their *levels*. In an examination of changes in house prices in London relative to other regions of the UK, directional forecasting methods are employed to establish the extent of the relationship between geographical proximity and comovement across the three month window provided by quarterly data. Consequently, the analysis provides a direct examination of the ripple effect which refers to *changes* in prices rather than the convergence of *levels* which has become a feature of the empirical literature. The literature is extended further by both the application of dating techniques to perform the analysis across cycles and phases of cycles (recovery and recessionary periods) in the UK housing market, and the use of data from two alternative house price index providers. Striking results in support of the presence of a ripple effect are noted, particularly for the less commonly considered Halifax price index where the most significant results for comovement with London are exhibited by its contiguous regions. In addition, the cyclical subsamples considered indicate comovement to be greater during upturns, rather than downturns in the market. This is consistent with previous research showing London to correct, i.e. exhibit differing behaviour to other regions, during downturns.

Keywords: House prices , Ripple effect , Comovement , Cyclical properties , Directional forecasting

1. Introduction

Over recent years, a large literature has evolved examining the properties of house prices and their relationships with other variables. That such a body of research should have emerged is unsurprising given the importance of the housing market in the macroeconomy. This has been highlighted in studies such as Holly and Jones (1997) where the substantial proportion of personal sector wealth accounted for by the housing market is noted, along with the impact of housing upon the aggregate economy. Similarly, Gallin (2006), Goodhart and Hoffman (2007) and Costello *et al*. (2011) note the importance of the role of housing in the macroeconomy and the extent to which movements in house prices are driven by 'fundamentals' or underlying economic factors. While a variety of topics has been examined, including the analysis of national house prices (as exemplified by the early studies of Nellis and Longbottom 1981; Hendry 1984), arguably the largest theme within the literature on the empirical analysis of house prices involves the examination of regional house prices and their interrelationships. Within this sub-literature, the notion of the ripple effect is prominent. Despite analysis of potential house price diffusion via the ripple effect having been undertaken for a number of economies (for example, Lee and Chien (2011), Payne (2012), Balcilar *et al*. (2013) and Lean and Smyth (2013) consider the existence of a ripple effect for Taiwan, the US, South Africa and Malaysia respectively), it is arguably the UK that has received the greatest attention. More precisely, studies such as those of Holmans (1990), MacDonald and Taylor (1993), Alexander and Barrow (1994), Drake (1995), Ashworth and Parker (1997), Meen (1999), Petersen *et al*. (2002), Cook (2003, 2005a, 2005b, 2012), Holmes and Grimes (2007) and Holmes (2008) consider the possibility that movements in house prices are first observed in London before moving to other regions of the UK. Using a collection of methods, the above studies have produced mixed results concerning the presence of a ripple effect.

The intention of the present paper is to add to the existing literature exploring the ripple effect in four ways. First, attention will be paid directly to the *movements*, or *changes*, in house prices to which the ripple effect refers, rather than their *levels*, as typically considered in the literature. That is, the empirical analysis is constructed to match the discussion of the ripple effect which is couched in terms of house price changes.

As a second development, a method typically employed to consider the forecasting of market movements in finance and financial economics is employed to undertake the econometric examination of the presence of a ripple effect. It is argued that the directional forecasting method afforded by application of the Pesaran-Timmermann (1992) test provides a means for the subsequent analysis for the following reason. The ripple effect relates to a diffusion of movements in house price across the UK from London to its contiguous regions and then beyond. Consequently, it is to be expected that a greater number of common, or coincident, movements will be noted when considering house prices changes in London and its neighbouring regions, than when considering London and more geographically distant regions. The use of the proposed method provides a formal mechanism for evaluating this hypothesis by providing evidence on the significance of comovement in regional house prices. As the ripple effect refers to change in house prices being observed in London before being transmitted to other regions, the above stated increased comovement in closer, rather than distant, regions is a clear implication of this hypothesis. In contrast, the frequent consideration of convergence and application of relevant techniques in the literature, involves a further assumption which moves a step away from the hypothesis. That is, while changes may spread across the UK, that does not necessarily imply convergence if changes are of different sizes as, for example, initially higher priced regions may pull away from others or a lower priced regions may change by a greater amount and leapfrog others (both of these being issues considered in the macroeconomic analysis of convergence).

In a third extension of the literature, recent developments considering the importance of distinguishing between upturns and downturns, and cyclical effects more generally, in the UK housing market (see Cook 2005b, 2012) are incorporated in the analysis. Using a business cycle dating technique, peaks (booms) and troughs (busts), and hence underlying cycles, are identified in the housing market. The underlying motivation for this effective split-sample analysis is the potential differing behaviour of regional house prices during different phases of the business cycle and the ensuing neglect of this which results from the use of a single sample combining these differing phases. Finally, and in contrast to the majority of the literature, two house price data providers rather than a single index are considered to examine both the robustness of the results obtained and any resulting differences in information provided by alternative sources of housing market information.

To achieve its objectives, this paper will proceed as follows. In the following section the relevant empirical literature on the analysis of a ripple effect is reviewed. In Section [3] the methodology employed is discussed, with Section [4] discussing the data series considered and undertaking the required business cycle dating to derive the required cyclical subsamples. Section [5] presents the results obtained from the empirical analysis of the ripple effect. Concluding remarks provided in Section [6].

2. The ripple effect: A summary of the empirical literature

In recent years, investigators have employed a variety of tools and techniques to explore the possibility of a ripple effect operating within the UK housing market. Simply put, the ripple effect posits a relationship whereby changes in house prices in the UK are noted first in the London and the South East of England before being observed in other regions. To attempt to summarise the resulting vast empirical literature on this phenomenon, it is possible to categorise the various relevant studies in terms of their interpretation of this hypothesis or whether they have decided that a qualification or extension needs to be placed upon it. For example, an obvious (econometric) interpretation of the hypothesis that London leads the UK housing market is that it is the ‘causing' region for other areas.[1, 2] As a consequence, Guissani and Hadjimatheou (1991) and Alexander and Barrow (1994) employed Granger causality tests to establish a causal relationship running from the South East to the North. In a similar fashion, Guissani and Hadjimatheou (1991) and Petersen *et al*. (2002) viewed the ripple effect as implying correlation between house prices, producing results which were supportive of the hypothesis.

An alternative perspective on the ripple effect hypothesis, which is arguably the most dominant in the literature, is to view the transmission of changes in house prices across the UK to imply a short-term divergence, but a longer term convergence, in regional house prices. That is, while house prices in London may change first, the changes do eventually reach other regions. An obvious econometric translation of this is stochastic convergence.[3] As a result, investigators have examined whether regional:national house prices

[1]It must be noted that the notion of causality in this context relates to a form of temporal precedence where changes are witnessed earlier in one region than another, rather than in the more everyday sense of cause and effect. That is, Granger causality considers changes in London occurring before other regions and hence being a `predictor', rather than a direct causal transmission mechanism existing.

[2]In the interests of structuring the review of empirical techniques provided in this section, the alternative methods employed in the literature have been separated and discussed in turn. Obviously it is possible for studies to consider more than one technique, and many studies have considered multiple methods. We are grateful to a referee for raising this issue.

[3]The remaining discussion in this section considers stochastic convergence, its extension to consider asymmetric adjustment and the subsequent consideration of cyclical effects in the housing market. As a consequence research involving Kalman filtering (Drake, 1995) and principal component analysis (Holman and Grimes, 2008) are not discussed in detail. While important and interesting lines of

are stationary or, less restrictively, whether regional house price series are cointegrated. With regard to the first line of research, earlier studies such as Holmans (1990), Meen (1999) and Petersen *et al*. (2002) provide little evidence of the presence of stationarity in such ratios. However, the more recent research of Cook (2005a) has questioned whether these results are due to the testing approach adopted. Rather than consider the more routine augmented Dickey-Fuller (1979) test, Cook (2005a) employed a more sophisticated testing procedure involving confirmatory analysis via the joint application of the GLS-Dickey-Fuller unit root test of Elliott *et al*. (1996) and the KPSS test of Kwaitkowski *et al*. (1992). It was found that application of this revised procedure produced greater support for the ripple effect in the form of increased evidence of convergence between regional price ratios. Similarly, an alternative extension provided by Holmes (2007) to consider panel unit root testing methods provided increased support for convergence and hence the ripple effect.

To explore potential cointegration between regional house prices series, investigators have employed the methods of both Engle-Granger (1987) and Johansen (1988). In line with the conclusions drawn from earlier studies examining the stationarity of regional house price ratios, the results of MacDonald and Taylor (1993), Alexander and Barrow (1994) and Ashworth and Parker (1997) provided limited support for the existence of a ripple effect using cointegration techniques.[4]

The above discussions show clearly how views on the nature of the ripple effect can shape the particular empirical approach adopted to examine its existence. However, what might be considered also is whether the broad statement provided by the ripple effect concerning a transmission of house price movements across the UK requires some extension or qualification. A prominent and obvious example of such a qualification concerns the questioning of whether the transmission might take a different form at different times. An early examination of this is provided by the works of Cook (2003, 2005b) where asymmetric unit root and cointegration analyses were undertaken to consider the possibility that the extent of any convergence within the housing prices may be dependent upon whether the housing market is experiencing

research, they are individual pieces and do not represent a body of work or repeated use of a particular approach as is the case with stochastic convergence. It should be noted that the results from these studies are contrasting in nature with the findings of Drake (1995) being less supportive of the presence of a ripple effect than those of Holman and Grimes (2008).

[4]While the above discussion has focussed upon the UK, similar analyses of stochastic convergence using unit root tests and autoregressive distributed lag models have been conducted by, *inter alia*, Payne (2012), Balcilar *et al*. (2013), Lean and Smyth (2013) and Lee and Chien (2011) for the US, South Africa, Malaysia and Taiwan, respectively, with mixed results being obtained.

an upswing or downswing. Drawing upon the momentum threshold autoregressive (MTAR) methods of Tong (1990), Enders and Granger (1998) and Enders and Siklos (2000), increased evidence of convergence was detected relative to the use of symmetric methods. Interestingly, differing speeds of adjustment during different phases of the market were noted along with differing behaviour across regions. In particular, increased convergence was observed during downswings with South East house prices 'correcting' dramatically to draw closer to those for other regions. This noted variation in the evidence supporting the presence of a ripple effect according to the phase of the cycle examined led to the research of Cook (2012) which focussed more closely on the cyclical dependence of the ripple effect. Using the methods of Drennan and Lobo (1999) and examination of the spread of regional house prices through time, the potential convergence of house prices was analysed over differing phases of the business cycle. The results obtained indicated a convergence in house prices in the form of a narrowing of their dispersion across regions through time σ-convergence and the more rapid growth of prices in regions with lower initial house prices β-convergence, with this convergence more substantial during downturns, rather than upturns, in the housing market.

The present analysis extends, or develops, the existing literature via consideration of changes in house prices, the use of a novel non-parametric method, consideration of cyclical samples and the analysis of data from two house price providers. While first differences of house prices have been considered previously in the literature as a result of the need to ensure certain properties are satisfied in the application of linear regression for example, the current analysis provides a first analysis of comovement between first differences to match the focus on changes present in the ripple effect. To allow this analysis to be pursued, the following section presents the non-parametric to be employed.

3. Methodology

The intention of the present study is to consider the extent of comovement between changes in London house prices and changes in house prices in other regions of the UK. The first step in this analysis is straightforward, simply requiring the changes in house prices to be created via first differencing. That is, denoting the house price in region i as h_{it}, the change is given as Δh_{it}. The next step in the analysis is more involved. The ripple effect relates to the relationships between Δh_{it} and the notion that the changes are observed first in London before filtering out across the rest of the UK. As such, the ripple effect implies a greater degree of comovement will be observed when considering house changes for London and its contiguous regions, than when considering London and more geographically distant regions. To examine the extent of evidence in support of this hypothesis, the comovement between changes in London house prices and those for other regions can be examined via use of the Pesaran and Timmermann (1992), hereafter denoted as the PT test.

The PT test involves a non-parametric approach to the examination of the extent of comovement between two series. Typically, this test is used as a directional forecasting technique. The simple framework and resulting S_n test statistic focus upon the possibility of the direction of change of a variable being predicted correctly by another. In essence, the test considers whether two variables move in the same direction, with an increase or decrease in both observed in a given period. Consequently, the test has received attention in finance and financial economics where the prediction of market movements has obvious importance and benefits for speculators. However, as noted above, the test can be used in the present context to explore the coincidence of regional price movements in the housing market.

Given two variables of interest denoted as (y_t, x_t), the S_n statistic of PT is based upon binomial arguments and is given as:

$$(1) \quad S_n = \frac{\hat{P} - \widehat{P_*}}{\left[\hat{V}(\hat{P}) - \hat{V}(\widehat{P_*})\right]^{0.5}} \overset{a}{\sim} N(0,1)$$

where:

$$(2) \quad \hat{P} = n^{-1} \sum_{t=1}^{n} I(y_t x_t)$$

$$(3) \quad \widehat{P_*} = \widehat{P_y}\,\widehat{P_x} + \left(1 - \widehat{P_y}\right)\left(1 - \widehat{P_x}\right)$$

$$(4) \quad \hat{V}(\hat{P}) = n^{-1}\,\widehat{P_*}\left(1 - \widehat{P_*}\right)$$

$$(5)\quad \hat{V}(\hat{P}_*) = n^{-1}\left(2\hat{P}_y - 1\right)^2 \widehat{P_x}\left(1-\widehat{P_x}\right) + n^{-1}\left(2\hat{P}_x - 1\right)^2 \widehat{P_y}\left(1-\widehat{P_y}\right) + 4n^{-2}\,\widehat{P_y}\,\widehat{P_x}\left(1-\widehat{P_y}\right)\left(1-\widehat{P_x}\right)$$

$$(6)\quad \widehat{P_y} = n^{-1}\sum_{t=1}^{n} I(y_t) \quad \widehat{P_x} = n^{-1}\sum_{t=1}^{n} I(x_t)$$

$$(7)\quad I(\cdot) = \begin{cases} 1 & if\ \cdot > 0 \\ 0 & otherwise \end{cases}$$

In the present analysis, $\{x_t\}$ is given as Δh_{it} for London, with $\{y_t\}$ given as Δh_{it} for the other regions in turn to explore the comovement between London and the other regions of the UK.

4. Data and business cycle dating

4.1. Data

The data examined in the present study are quarterly observations on regional house prices available from two providers. The first series contains Nationwide Building Society data which provide observations on mixed-adjusted house prices for all properties over the period 1973(4) to 2013(3) for the following regions of the United Kingdom: North (NOR), Yorkshire and Humberside (YH), North West (NW), East Midlands (EM), West Midlands (WM), East Anglia (EA), Outer South East (OSE), Outer Metropolitan (OMET), London (LON), South West (SW), Wales (WAL), Scotland (SCOT) and Northern Ireland (NIRE). The second set of data, from the Halifax Building Society, are observations for `all houses' over the period 1983(1) to 2013(3) for the following regions: North (NOR), North West (NW), Yorkshire and Humberside (YH), East Midlands (EM), West Midlands (WM), East Anglia (EA), South West (SW), South East (SE), London (LON), Wales (WAL), Scotland (SCOT) and Northern Ireland (NIRE). Therefore, the providers differ not only with regard to sample span, but, more importantly, the number and definition of regions considered.

4.2. Business cycle dating

As noted previously, the research of Cook (2003, 2005b) has considered the possibility of relationships between regional house prices varying at differing times in the form of differential speeds of adjustment to defined underlying equilibria. This prompted more recent research of Cook (2012) in which business cycle dating techniques were employed to derive cyclical subsamples within which to consider the presence of a ripple effect.[5] The results obtained showed that while convergence between regional house prices was apparent during the whole sample period (1973-2009) considered, it was driven by a noted convergence during identified cyclical downturns in which regional house prices drew closer together. In the present research, the approach of Cook (2012) is adopted in terms the dating method employed to identify turning points in the cycles in the UK housing market.

To identify peaks and troughs in house prices, Cook (2012) drew upon the work of Birchenhall *et al*. (2001) and Cook and Thomas (2003). The rules employed to derive turning points under this approach are provided in Table One. From inspection of Table One, it can be seen that peaks in house prices are defined as observations with values (*i*) greater than or equal to values observed in the previous eight periods, (*ii*) strictly greater than values in the following two periods months and (*iii*) greater than or equal to values observed between two and eight periods ahead. Similarly, troughs are defined as periods with values (*i*) less than or equal to values observed in the previous eight periods, (*ii*) strictly less than values in the following two periods and (*iii*) less than or equal to values observed between two and eight periods ahead. More simply, given the quarterly nature of the data considered, peaks (troughs) are periods which are relatively high (low) over a two year period. With peaks and troughs identified, cyclical subsamples can be created by considering movements between them. However, before such subsamples can be derived for the Nationwide and Halifax house prices series under investigation, a decision is required regarding the appropriate series to which to apply the dating method. Fortunately such a decision is relatively straightforward given the prime importance of London in the current analysis, with this region employed as the arbiter of cyclical turning points in the UK housing market.

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[5] Consideration of cyclical behaviour in UK house prices is present also, albeit in a different manner, in the research of Cook and Holly (2000) and Cook (2006). While the former study considered potential common cycles in the prices of different vintages of housing stock, the latter examined potential asymmetries in regional house prices.

[TABLE ONE ABOUT HERE]

Application of the dating method to the series considered herein produced the results presented in Table Two. Inspection of the results of obtained show both general and specific consistencies between the house price series considered. More generally, both series identify two peaks and two troughs in the period considered, and while the dating is not identical across the series, they are relatively close. On a more specific note, the Nationwide index identifies peaks which occur later, and troughs that occur earlier, than the corresponding Halifax series. While the two troughs are one period earlier, the first peak is two periods later than that of the Halifax index, while the second peak occurs one period later.

[TABLE TWO ABOUT HERE]

With the peaks and troughs of the series identified, the cyclical subsamples involving periods between them can be identified. In addition to considering the full sample for each data provider, the detection of two peaks and two troughs permits five cyclical subsamples to be considered. Denoting the peaks (P) and troughs (T) as $\{P_1, P_2, T_1, T_2\}$, where the subscripts relate to the temporal ordering of the particular type of turning point, two full cycles are present $\{P_1\ to\ P_2;\ T_1\ to\ T_2\}$. The remaining three cyclical subsamples are $\{P_1\ to\ T_1;\ T_1\ to\ P_2;\ P_2\ to\ T_2\}$, and these relate to downturns in the first and last case, and an upturn for the second case.

5. Empirical results

5.1. Unit root test results

Before considering comovement between London and other regional house price series, the properties of all series are considered via application of unit root tests. To illustrate the notion of a unit root, consider a series denoted as $\{y_t\}$. Considering the simplest case, y_t is said to possess a unit root if the first order autoregressive coefficient (ρ) is equal to 1 in the following regression:

$$(8) \quad y_t = \rho y_{t-1} + v_t$$

where v_t is an error process. The unit root null is therefore expressed as H_0: $\rho = 1$. Under this null, the series can be shown to possess a trend in its variance and deemed non-stationary. As a result, non-standard distribution theory will be required and the properties of the series will present various problems for alternative forms of analysis. In contrast, the series will be referred to as (asymptotically) stationary under the alternative H_0: $\rho < 1$. While stationarity is not a necessary condition for the application of the PT test, its presence avoids recourse to a further condition for valid use of the test.[6]

Following convention, the higher powered GLS-based Dickey-Fuller (DF-GLS) test of Elliott et al. (1996) is employed to test the unit root hypothesis in the regional house prices series (h_{it}) and their first differences (Δh_{it}). Given the nature of the series, an intercept and linear trend term are employed as the relevant deterministics in the testing equation when analysing the trending h_{it} series, while an intercept alone is employed for the non-trending Δh_{it}. In all instances the degree of augmentation of the testing equations utilised is terms determined using the modified Akaike information criterion (MAIC).

The results obtained from application of the tests are provided in Table Three are straightforward to interpret as in all instances the unit root null hypothesis is not rejected for the regional price indices (h_{it}), but is rejected at the 5% level of significance or beyond for the the first differences of the regional price indices (Δh_{it}) with very few exceptions. More precisely, the three instances where rejection does not occur for the first differences (London and Scotland for the Nationwide index; Scotland for the Halifax index) are extremely borderline as rejection occurs just beyond the 5% level. In light of the differing statistics obtained for the original (h_{it}) and differenced (Δh_{it}) series in these instances, along with the properties of the test employed (i.e. higher, but not 100%, power), the house price series will be deemed render stationary via differencing. As subsequent PT tests will be applied to the first differences of the house

[6] If the series to be considered are not stationary, the PT test requires series to be distributed symmetrically about zero for its valid application.

price series, the results show the series to be examined are stationary as required.

[TABLE THREE ABOUT HERE]

5.2. Results on regional comovements: The Nationwide index

The results obtained from application of the PT test to the Nationwide house price indices are presented in Table Four.

[TABLE FOUR ABOUT HERE]

From inspection of Table Four it can be seen that the initial results for the full sample (F.S.) indicate extensive comovement of all regions with London. Under the hypothesis of a ripple effect, it would be anticipated that the strength of this comovement would be positively correlated to the geographical proximity of a region to London. Evidence in support of this is apparent, with the Outer South East and Outer Metropolitan regions returning the most significant test statistics, while Northern Ireland, Scotland and the North return the least significant (albeit still significant at conventional levels) test statistics. Moving to the full cycle subsamples, the first of these relates to the cycle from the first to second peak $(P_1\ to\ P_2)$. The results obtained over this period follow a similar pattern to those for the full sample, albeit with reduced significance noted. In particular, the Outer South East, East Midlands and Outer Metropolitan regions generate the most significant results, while those for the North and Scotland are insignificant. The second full cycle $(T_1\ to\ T_2)$ can be seen to produce similar results again in terms of overall and relative significance across regions. Turning to the results for the 'part-cycle' samples, the recessionary period from the first peak to the first trough provides evidence of comovement between London and a number of geographically close regions, most notably the Outer South East, the Outer Metropolitan and East Midland regions, with more distant regions producing insignificant results. Again, this is consistent with the ripple effect. The results for the recovery period from the first trough to the second peak indicate increased comovement, with significant results observed for nine regions (as compared to six regions for the earlier recessionary period). The final recessionary period (from P_2 to T_2) produces overwhelming evidence of comovement for all regions, with the `NA' denoting that the test statistic cannot be calculated due to identical movement between the stated region and London in every period considered. However, it should be noted when interpreting these results that this final sample is very small and consequently identical comovement is not surprising.

When taken in combination, a clear picture emerges from the results for the Nationwide index. This can be summarised by three points. First, the geographically closer regions exhibit greater comovement with London, thus supporting the presence of a ripple effect in the form of a similar movement with that observed in London occurring more often within a three month period for contiguous and nearby regions. Second, when considering the cyclical subsamples, there is more comovement during recovery, rather than recessionary, periods. This is reflected in the average test statistics noted for the $\{P_1 \text{ to } T_1\}$ and $\{T_1 \text{ to } P_2\}$ cyclical subsamples. The values obtained are 2.177 and 2.445 respectively showing increased comovement in the recovery subsample.[7] This fits with the previous research of Cook (2012) where convergence or `correction' was noted in recessionary periods with London prices falling relative to other regions with a narrowing of house price differentials observed as measured by the cross-sectional coefficient of variation. Here, the flipside of this movement, in the form of common movement in recovery periods, it apparent. That is, while London tends to exhibit different behaviour during downturns and hence `corrects' with the rest of the market, during upturns there is increased similarity of movement. In combination, these contrasting movements result in a general widening of house prices over the full cycles available in this analysis, from $\{P_1\ to\ P_2;\ T_1\ to\ T_2\}$, as measured by the ratio of regional house prices relative to London.[8] Finally, the most pronounced results are detected for the full sample period. This is unsurprising given the earlier results as the full sample includes a prolonged recovery period ahead of the first peak which is not contained within any of the other samples considered.

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[7] While these summary statistics are indicative of the extent of comovement over different phases of the business cycle, it is recognised that such average statistics do not provide information on the number of significant test statistics. However, such information is presented in the tables provided herein.

[8] We are grateful to a referee for prompting consideration of this issue. The analysis undertaken involved simple ratios of house prices in regions relative to those for London. Over the first full cycle these fell for all regions aside from `northern' regions (N, NW, SCOT, NIRE). Over the second cycle, the ratios were found to decrease for all regions aside from NIRE.

5.3. Results on regional comovements: The Halifax index

Table Five provides results on comovement for the Halifax house price index analogous to those in Table Four for the Nationwide index. The results follow a similar pattern to those for the Nationwide index, but are more striking in terms of their support for the presence of a ripple effect. Throughout, it is the contiguous regions that demonstrate the greatest degree of comovement with London. In particular, the South East and East Anglia regions produce the most significant results. As with the Nationwide index, the full sample produces the most significant results, with the recovery, rather than recessionary, phase over the cycle exhibiting more comovement. As with the Nationwide index, these results can be illustrated via average test statistics over the recessionary and recovery subsamples as while the average statistics for the two recessionary subsamples are 0.975 and 1.354, the value for the recovery period is 2.822. To illustrate the relationship between geographical proximity and comovement over the samples considered, Table Six ranks regions producing significant comovement with London in descending order of significance. From inspection of Table Six, the prominence of the South East and East Anglia is apparent indicating that the ripple effect and the diffusion of house price changes across the UK has an increased tendency to move in an easterly direction. This results in a ripple effect where diffusion of house price changes not fully reflect geographical proximity but rather has a bias towards movements in a particular direction. This issue clearly warrants further examination as the ripple effect makes no distinction between geographical location as opposed to geographical distance. Hence an observed tendency for diffusion in one direction rather than another is an interesting feature warranting close attention. In addition to the direction of diffusion, the tabulated results Table Six show the extent of comovement is greater during the recovery phase of the cycle rather than the recessionary phase.

[TABLES FIVE AND SIX ABOUT HERE]

6. Conclusion

The present study has sought to revisit the hypothesis of a ripple effect in the UK housing market. The analysis undertaken has extended the existing literature in a number of ways, principally via the consideration of a market movements approach. Using a directional forecasting technique to explore comovement, evidence in support of the presence of a ripple effect has been evaluated by consideration of the degree to which changes in regional house prices occur in the same direction as those observed in London. In particular, the degree to which this comovement was positively related to the geographical proximity of the regions to London was considered. As such, the ripple effect was evaluated by examining whether significant comovement was more apparent in those regions closer to London, as suggested by the ripple effect and the transmission of house price changes from London across the UK to other regions. In a further extension of the literature, the present research has considered house price data for alternative providers and has cyclical behaviour via the creation of subsamples relating to full business/economic cycles and part samples (recovery and recessionary periods).

The results obtained have provided evidence in support of the ripple effect showing a clear positive relationship between the geographical proximity of a region and the degree of comovement of the changes in its house prices with those in London. However, what was detected also from application of this new approach was a bias towards more rapid diffusion in an easterly rather than westerly direction. This finding was noted for both house price data providers, although more apparent for the Halifax house price series. In supporting the ripple effect, the results showed a tendency for house prices movements to be more apparent in an easterly direction with the South East and East Anglia being the regions exhibiting the strongest comovement with London. The resulting obtained from consideration of the cyclical subsample proved interesting. While the highly significant results of the full samples were apparent in the full cycles considered, the part cycles displayed slightly different findings. In particular, it was noted that the recovery phase displayed greater support for the ripple effect than the recovery phase. Such a finding has support in previous research where London was found to correct during recessionary phases. As such, London was found to display differing behaviour relative to other regions during downturns and hence draw closer to them. In the present analysis, the results depict the flipside of a noted increased difference during downturns, namely an increased similarity during upturns.

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Table One

Identifying Business Cycle Turning Points

Rules	Peak	Trough
i.	$\Delta_i y_t \geq 0 \quad i = 1, \dots, 8$	$\Delta_i y_t \leq 0 \quad i = 1, \dots, 8$
ii.	$\Delta_i y_{t+i} \leq 0 \quad i = 1, \dots, 8$	$\Delta_i y_{t+i} \geq 0 \quad i = 1, \dots, 8$
iii.	$\Delta_i y_{t+i} < 0 \quad i = 1,2$	$\Delta_i y_{t+i} > 0 \quad i = 1,2$

Notes: The above table contains the three dating rules required to identify peaks and troughs in a series denoted as y_t.

Table Two

Dating the Turning Points in the UK Housing Market

Turning Point	Nationwide	Halifax
Peak (P_1)	1989q2	1988q4
Trough (T_1)	1992q4	1993q1
Peak (P_2)	2007q4	2007q3
Trough (T_2)	2009q1	2009q2

Notes: The above dates are identified turning points in the Nationwide and Halifax house price indices. The turning points are denoted as $\{P_1, P_2, T_1, T_2\}$ for the first and second peaks and troughs respectively.

Table Three
Unit root test results for regional house prices

Nationwide			Halifax		
Region	h_{it}	Δh_{it}	Region	h_{it}	Δh_{it}
NOR	-2.411	-2.602**	NOR	-2.144	-2.087*
YH	-1.667	-2.207*	YH	-2.186	-2.257*
NW	-2.030	-2.029*	NW	-2.836	-2.152*
EM	-1.632	-2.114*	EM	-1.621	-2.129*
WM	-1.502	-2.112*	WM	-1.725	-1.977*
EA	-2.144	-1.944*	EA	-1.831	-2.267*
OSE	-1.453	-1.988*	SW	-1.806	-1.808
OMET	-1.249	-2.015*	SE	-1.385	-2.218*
LON	-0.835	-1.778	LON	-1.844	-2.197*
SW	-1.650	-1.899*	WAL	-1.839	-2.011*
WAL	-1.621	-1.994*	SCOT	-2.141	-1.847
SCOT	-2.229	-1.784	NIRE	-1.829	-3.220*
NIRE	-2.025	-3.138*			

Notes: The above tabulated figures are calculated values of the DF-GLS unit root test statistic for regional house prices (h_{it}) and their first differences (Δh_{it}). The testing equations include an intercept and trend for the price series and an intercept only for their first differences. The degree of augmentation of the testing equations are determined using the modified Akaike information criterion (MAIC). Rejection of the unit root null hypothesis at the 5% and 1% level of significance are denoted using * and ** respectively.

Table Four: Comovement in regional house prices: Nationwide Indices

Region	$F.S.$	P_1 to P_2	T_1 to T_2	P_1 to T_1	T_1 to P_2	T_2 to T_2
NOR	3.693 [0.022]	1.091 [27.546]	2.018 [4.364]	1.673 [10.171]	0.850 [39.529]	NA
YH	6.174 [0.000]	3.193 [0.141]	4.020 [0.006]	0.804 [42.164]	2.989 [0.280]	NA
NW	6.863 [0.000]	3.750 [0.018]	4.153 [0.003]	1.875 [6.079]	2.660 [0.780]	2.683 [0.729]
EM	7.863 [0.000]	5.526 [0.000]	4.844 [0.000]	3.324 [0.089]	3.808 [0.014]	NA
WM	6.603 [0.000]	3.798 [0.015]	3.199 [0.138]	2.835 [0.459]	1.734 [8.283]	NA
EA	5.629 [0.000]	3.387 [0.071]	2.572 [1.010]	2.339 [1.936]	0.962 [33.595]	NA
OSE	9.150 [0.000]	6.231 [0.000]	5.215 [0.000]	4.009 [0.006]	4.085 [0.004]	NA
OMET	9.091 [0.000]	5.438 [0.000]	4.690 [0.000]	3.324 [0.089]	3.523 [0.043]	2.683 [0.729]
SW	5.971 [0.000]	3.638 [0.023]	3.646 [0.027]	1.417 [15.638]	2.156 [3.106]	NA
WAL	7.308 [0.000]	4.158 [0.003]	4.295 [0.002]	2.143 [3.212]	2.973 [0.295]	2.683 [0.729]
SCOT	3.924 [0.000]	1.064 [28.725]	2.607 [0.913]	1.209 [22.676]	1.199 [23.040]	NA
NIRE	4.561 [0.000]	2.773 [0.055]	3.891 [0.010]	1.209 [22.676]	2.396 [1.659]	NA

Notes: The tabulated figures represent calculated Pesaran-Timmermann test statistics for comovement between London and the stated regions. The figures in square brackets are associated p-values for the significance of the test statistic expressed in percentage terms. The six samples considered are the full sample (F.S.) and five cyclical subsamples considering movements between turning points.

Table Five: Comovement in regional house prices: Halifax Indices

Region	$F.S.$	P_1 to P_2	T_1 to T_2	P_1 to T_1	T_1 to P_2	T_2 to T_2
NOR	3.885 [0.010]	2.682 [0.858]	3.251 [0.115]	0.437 [66.243]	3.042 [0.235]	-1.008 [31.350]
YH	3.905 [0.009]	3.022 [0.251]	3.617 [0.030]	0.873 [38.259]	2.288 [2.214]	1.979 [4.776]
NW	3.425 [0.062]	2.358 [1.837]	3.199 [0.138]	1.381 [16.742]	2.096 [3.612]	1.008 [31.350]
EM	5.846 [0.000]	5.047 [0.000]	5.215 [0.000]	0.242 [80.865]	3.716 [0.020]	3.024 [0.250]
WM	5.504 [0.000]	3.665 [0.025]	3.825 [0.013]	0.873 [38.259]	2.909 [0.363]	1.008 [31.350]
EA	7.407 [0.000]	6.160 [0.000]	5.507 [0.000]	1.381 [16.742]	4.615 [0.000]	2.254 [2.421]
SW	5.673 [0.000]	5.114 [0.000]	3.646 [0.027]	2.087 [3.687]	2.553 [1.068]	1.008 [31.350]
SE	7.988 [0.000]	6.917 [0.000]	5.824 [0.000]	2.087 [3.687]	5.425 [0.000]	1.008 [31.350]
WAL	4.030 [0.006]	3.022 [0.251]	2.796 [0.518]	1.112 [26.594]	1.706 [8.800]	1.008 [31.350]
SCOT	3.097 [0.195]	1.202 [22.944]	3.405 [0.066]	0.690 [49.003]	2.288 [2.214]	2.254 [2.241]
NIRE	1.721 [8.528]	1.642 [10.062]	1.758 [7.874]	-0.437 [66.243]	0.309 [75.736]	-0.660 [50.936]

Notes: The tabulated figures represent calculated Pesaran-Timmermann test statistics for comovement between London and the stated regions. The figures in square brackets are associated p-values for the significance of the test statistic expressed in percentage terms. The six samples considered are the full sample (F.S.) and five cyclical subsamples considering movements between turning points.

Table Six: Ranking the extent of regional comovement: Halifax Indices

$F.S.$	P_1 to P_2	T_1 to T_2	P_1 to T_1	T_1 to P_2	T_2 to T_2
1 SE	1 SE	1 SE	1= SE	1 SE	1 EM
2 EA	2 EA	2 EA	1= SW	2 EA	2= EA
3 EM	3 SW	3 EM		3 EM	2= SCOT
4 SW	4 EM	4 WM		4 NOR	4 YH
5 WM	5 WM	5 SW		5 WM	
6 WAL	6= YH	6 YH		6 SW	
7 YH	6= WAL	7 SCOT		7= YH	
8 NOR	8 NOR	8 NOR		7= SCOT	
9 NW	9 NW	9 NW		9 NW	
10 SCOT		10 WAL			
11 NIRE					